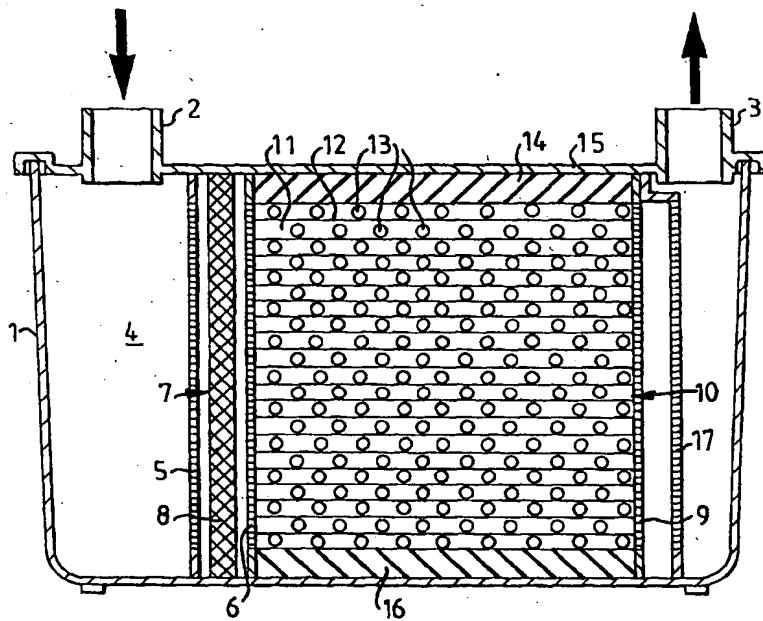




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(54) Title: APPARATUS FOR SEPARATION OF SOLIDS FROM A LIQUID



## (57) Abstract

A separation apparatus, in particular intended for separation of amalgam from water, comprising a pre-sedimentation chamber (4), a distribution chamber (7) and a fine sedimentation zone (10). The fine sedimentation zone consists of a plate package, comprising a plurality of plates (12) fixed with spaces (11), forming sedimentation channels. The plates (12) can be machined so that they are provided with a large number of fine bumps and recesses.

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### Apparatus for separation of solids from a liquid

This invention relates to an apparatus for separation of solids from a liquid and in particular an apparatus for separation of amalgam from water.

5

Discharge of amalgam as a source of mercurial poisoning has resulted in increasingly demands for amalgam separation from dentisteries. The proposed apparatus for dentisteries for amalgam separation are based on the standard operations, such as centrifugation, filtration, settling and combinations thereof.

10

Centrifugation apparatus suffer from disadvantages, such as complexity, cost and operational disturbance inter alia due to rotor imbalance caused by fouling.

15

Filtration apparatus, for instance that disclosed in EP-A-0 691 151, faces problems with trough flow capacity due to high pressure loss. To be able to filtrate amalgam particles of  $\mu$ -size, very fine filters are required. To achieve suitable through flow high external pressure is required by means of external pumping equipment risk for break down.

20

DE-A-4 243 239 discloses an apparatus comprising to serial connected settling containers and also filtration stages in front of the inlet in each of the containers. Furthermore, the apparatus also comprises a membrane pump and a cyclone separator, whereby disadvantages with complex apparatus, such as cost of apparatus, size and regeneration problems are obvious.

25

For the separation of solids from liquids by pure settling, there are known a large number of apparatus, based on the principle of laminar flow trough channels between corrugated or planar lamellas. Especially for separation of amalgam SE-B-469 510 discloses a sedimentation apparatus, consisting of a large number of contacting tubes, offering a substantial sedimentation surface. However, such tube packages are hard to recondition 30 for reuse. Furthermore non- smooth surfaces in open tubes offer optimum adhesion of settled amalgam sludge bearing in mind that extreme apparatus vibrations and unexpected

fluctuations in flow very well may occur during long continuos operation, even months, which is required because of practical reasons in a dentistry.

The object of the present invention is to provide a simple amalgam separator having a  
5 high degree of separation and safe retention capability with respect to amalgam during a relatively long time of operation, and which is also easy to clean from amalgam for reuse.

This object is attained according to the invention by an apparatus, which in the direction of flow for the liquid, which is to be cleaned from amalgam, comprises a pre-settling  
10 zone and finally a fine settling zone, which consists of a plate package with a plurality of spaced apart substantially parallel to each other fixed plates, and which preferably, at least on the upper side have a large number of fine bumps and recesses achieved by procedures known in the art.

15 By means of the plate package, being the critical part of the separator according to the invention, a large settling area and short sedimentation distances are obtained. Using for instance 30-60 plates, each having a surface of  $2 \text{ dm}^2$ , the flat settling area will be  $60-120 \text{ cm}^2$ . The specific settling area based on fine amalgam particles is further multiplied if the surfaces are provided with a large number of bumps and recesses by known  
20 manufacturing methods, such as pattern rolling, stamping, blasting etc. In addition to enlarging the surface, the grooves in the plates increase the retention effect of amalgam powder. The plates can be made of non-metallic material as well as metallic material. However, metal plates are preferred due to higher affinity for amalgam. The distance between onto each other resting plates in the package should be within the 1- 5mm range  
25 and is achieved conveniently from stamped bumps in the plates according to a known pattern from for instance the technology of plate heat exchanger technology. The individual plates in the package are preferably demountable hold together with all forms of screws.

30 According to a particular preferred embodiment of the invention, the spacing between the plates are filled out with packing pieces of 1-5 mm size. Hereby, a liquid element is forced to a labyrinthic and longer distance of flow trough the plate package and

undergoes a number of bendings and collisions, which has shown to have a favourable effect on the settling of particles of amalgam despite a higher average velocity for the liquid compared to open plate spacing. However, the velocity of the liquid can be kept sufficiently low, which working examples have shown by reaching a very high degree of separation in a separator according to the invention having plate spaces filled with granules. The packing pieces between the plates promotes further homogenous flow distribution over the plate package cross section and ensures also symmetrical load on all deposition surfaces.

10 According to yet another preferred embodiment of the invention, the plate spaces are filled with plastic granules having a density slightly lower than water. Because the granules flows up in water, the reuse of pure granules is facilitated in the reconditioning step of the separator

15 To be able to assure slow flow through the separator, a perforated wall is preferably arranged downstream of the fine settling zone and in front of the outlet from the separator, the total area of said wall being considerably smaller than the area of the rest of the perforated walls which preferably delimit the fine distribution zone and the distribution chamber ahead of the same. By the static pressure at the inlet of the

20 separator, normally within the range 0-0,1 kg/cm<sup>2</sup> and the flow limiting wall before the outlet, the maximum flow through the separator is totally under control.

The invention is further illustrated by a preferred embodiment thereof, with reference to the appended drawing where Fig. 1 shows a vertical section through a schematic separator and Fig. 2 shows a plate package from above.

The separator according to Fig. 1 consists of a container 1, comprising an outlet 2 in the top at one of its ends and an outlet 3 in the top at the opposite end. In use, the inlet 2 is connected to a waste water duct from a dentistry and the outlet 3 to drainage. From the inlet 2, the water to be cleaned flows first down to a pre-sedimentation chamber 4, where all forms of coarser particles settle. The pre-settling chamber 4 is delimited in the direction of flow by a perforated plate 5, which together with another perforated plate 6

delimit a distribution chamber 7. In the distributor chamber 7, a wire grid 8 is provided to further eliminate possible particles, which could hazard free passage of liquid through all the holes in the plate 6.

5 Between the distribution plate 6 and another perforated plate 9 is a plate package 10, comprising a plurality of fixed plates 12 spaced apart. The spaces 11 are filled with plastic granules 13. A sealing means between the plate package 9 and a container lid 15, and a sealing means 16 seals the plate package so that all flow of liquid occur through the spaces filled with granules 11.

10

Behind the plate package 10, but in front of the outlet 3, another plate 17 is arranged with holes distributed over the entire cross section, with a total hole area being substantially smaller than the area of each of the perforated plates 5, 6 and 9. The plate 17 thereby has a flow limiting function for the flow of liquid through the separator.

15

Fig. 2 shows a plate package 9, removed from the separator, from above. Notches 18 in each plate 12 correspond with guides in the container 1. A number of bumps 19 forms distances between the plates in the package 10. Nuts 20 on top threaded rods 21 through the complete plate package 10 hold it together. In each plate 12 a hole 22 is punched, so that a vertical channel is formed through the plate package 10 for refill of packing pieces 13 when the plate package 10 is positioned into the container 1.

20 In addition to the described embodiment, it will be understood that variations and modifications can be made within the scope of the invention as described in the appended claims. For instance, the plates can be corrugated or have wave shaped surfaces instead of flat. In stead of a single plate package, several plate packages can be coupled serial to the first one, whereby both, one or none thereof are filled with granules in the plate spaces.

25 Furthermore, the space distribution between the different zones in the separator, can vary depending on application. If, for instance, the load at a certain dentistry is unusually high, but still long operation time before exchange of separator is required, the pre-settling

zone 4 in the showed separator can be exchanged by, for instance a whole separate container 1, which is empty or just contains one or more coarse separation nets or similar.

**Claims**

1. Apparatus for separation of particles from a liquid, in particular for separation of  
5 amalgam from water, comprising a container (1) provided with an inlet (2) for particle contaminated liquid, a pre-settling zone (4) in communication with said inlet (2) for settling of coarser particles, a distribution chamber (7) provided for uniform distribution of the flow of liquid into a fine sedimentation zone, communicating with an outlet (3) for purified liquid, characterized in that said pre-settling zone comprises  
10 at least one plate package (10) comprising a plurality of parallel fixed plates (12), stacked and spaced (11) to each other, having preferably at least on the top surface a large number of fine bumps and recesses.
2. Apparatus according to claim 1, characterized in that the plate spaces (11) between the  
15 plates (12) are filled with packing pieces (13) with a size of 1 to 5 mm.
3. Apparatus according to claim 2, characterized in that the packing pieces (13) consist of plastic granules with a density lower than 1 g/cm<sup>3</sup>.
- 20 4. Apparatus according to any one of the preceding claims, wherein the distribution chamber (7) is separated from the pre-settling zone (4) as well as from the fine settling zone by perforated elements (5, 6), characterized in that between the fine settling zone and the outlet (3), a perforated wall (17) is arranged, wherein the total hole area of said wall is substantially smaller than the area of each of said perforated elements (5, 6).
- 25 5. Apparatus according to any one of the preceding claims, characterized in that the plates (12) in the plate package (10) are made of metal.
6. Apparatus according to any one of the preceding claims, characterized in that each  
30 plate (12) in the plate package (10) has one or more concentric holes (22) for filling of packing pieces (13) when the plate package (10) is placed in the container (1).

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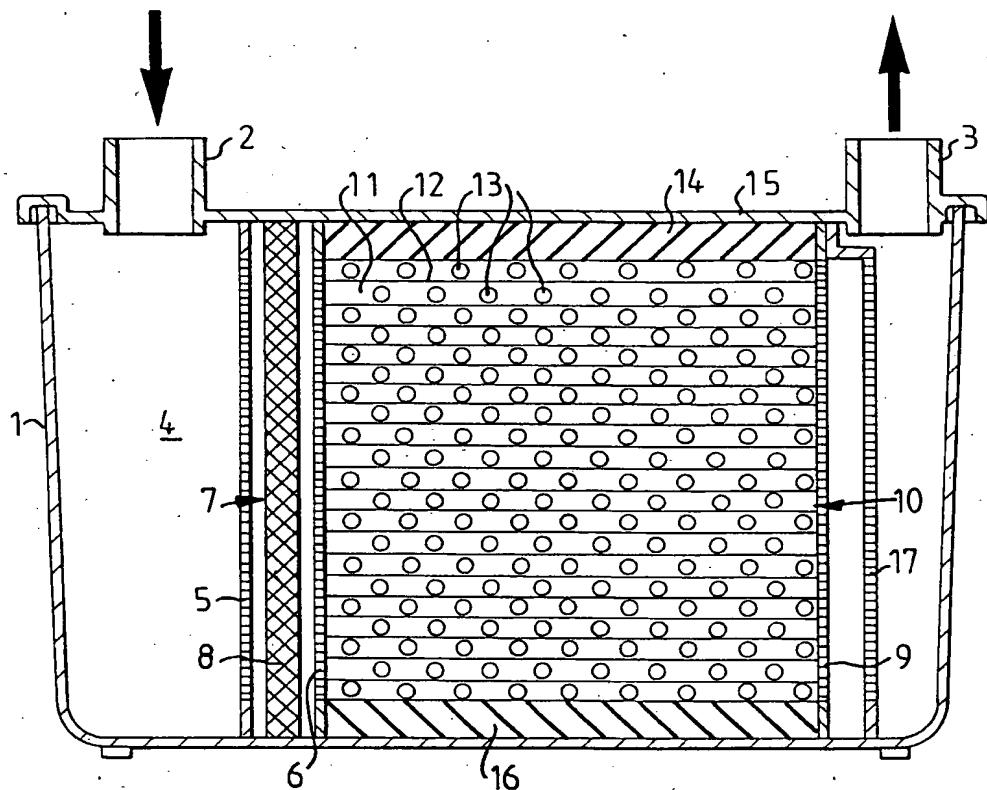


FIG. 1

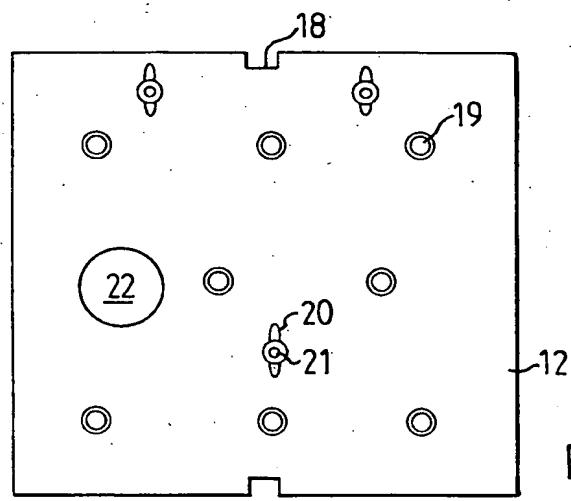


FIG. 2

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 98/00685

## A. CLASSIFICATION OF SUBJECT MATTER

### **IPC6: B01D 21/00**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0445093 A2 (STIFTELSEN CENTRUM FÖR DENTALTEKNIK OCH BIOMATERIAL I HUDDINGE), 4 Sept 1991 (04.09.91), figures 3,6, abstract  --	1-6
A	US 4419107 A (RICHARD H. ROYDHOUSE), 6 December 1983 (06.12.83), figure 2, abstract  -----	1-6

Further documents are listed in the continuation of Box C.

See patent family annex.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0445093 A2	04/09/91	AT 108686 T DE 69102907 D,T SE 469510 B,C SE 9000524 A US 5114578 A	15/08/94 08/12/94 19/07/93 15/08/91 19/05/92
US 4419107 A	06/12/83	NONE	